DOE-ID NEPA CX DETERMINATION
Idaho National Laboratory

CX Posting No.: DOE-ID-INL-15-011

SECTION A. Project Title: SAM-1 Hydraulic Shuttle Irradiation System (HSIS) Experiments

SECTION B. Project Description:

The purpose of the SAM-1 experiment is to populate a sample library to obtain data for low fluences of metallic fuels. Fuel for the proposed action would be manufactured from Department of Energy (DOE)-owned depleted uranium. Following irradiation in the Advanced Test Reactor (ATR) at the Idaho National Laboratory (INL), the samples would be available for post-irradiation examination (PIE) as part of a separate proposal process. Programs seeking to conduct PIE on the proposed sample library would require project specific environmental checklists.

The proposed experiments have a cross-cutting relevance to both the Advanced Fuel Cycle Initiative (AFCI) and the Reduced Enrichment for Research and Test Reactors (RERTR) program. This research would provide critical data where none currently exists. These data would serve to elucidate early microstructural development and mechanisms, as well as provide critical data for models under development in both programs. The goal of the AFCI is to develop fuels for the Generation IV Nuclear Energy Systems (Gen IV). These fuel systems are intended to reduce the volume of high-level radioactive waste, reduce the radiotoxicity of the repository, and utilize the energy content of spent nuclear fuel. New metallic fuel pins are under consideration for the actinide transmutation mission in future fast reactors. As AFCI undertakes a new metallic fuel development program to investigate alloys appropriate for the actinide transmutation mission, alloys substantially different from those developed as part of past United States (U.S.) breeder reactor programs, the experimental infrastructure of fast test reactors and post-irradiation examination (PIE) capabilities are more limited. Therefore, there is an effort aimed at developing a new fuel performance code that is science-rooted with a design-capable microstructural model that does not require empirical parameters. It is thought that this model can later serve to design fuel alloys for AFCI's actinide transmutation mission in fast reactors, and identify critical fuels for experimental performance evaluation (i.e., critical function to reduce irradiation experiments required for validation).

This proposal is focused on providing key, in-pile data, either as input to the model or for validation purposes. The proposed action would utilize the newly installed HSIS within ATR. The changes that would be examined in the proposed action include defect formation, fission product nucleation, constituent redistribution and microstructural degradation.

The proposed action would conduct four concurrent experiments. Three shuttle trains would be irradiated for short (1 day), medium (7 day), and long (30 day) periods, corresponding to fast (E > 1 MeV) neutron fluences of 7.0E18 n/cm2, 5.0E19 n/cm2, and 2.0E20 n/cm2 respectively. Two of the four experiments have closely aligned objectives, which are to investigate the effects of neutron irradiation on thermal conductivity of uranium oxide and thorium oxide. A third experiment would evaluate the irradiation stability of a fiber-optic-based temperature sensor. The fourth experiment seeks a greater understanding of irradiation damage to nuclear grade graphite from the initial dose realm (where current damage theories explain changes in thermal conductivity quite well), to higher doses where the current theory does not offer an adequate explanation.

Preliminary investigations indicate that after irradiation, all the shuttle capsules could be transported as Department of Transportation (DOT) Type A shipments using relatively small shielded containers.

The following specific activities would be performed at the Idaho National Laboratory (INL):

- experiment development and design
- neutronic, thermal/hydraulic, and structural analysis of the experiment components
- marking specimens, encapsulating specimens, machining and welding capsule end caps
- preparing the Experiment Safety Assurance Package (ESAP) and obtaining approval of the package, allowing experiment receipt at ATR, reactor insertion, irradiation, discharge, storage in the canal, and shipping
- shipping the experiment assemblies from the assembly facilities to ATR
- receiving the experiment assemblies at ATR
- inserting the experiments in the ATR and irradiating to specified conditions
- experiment handling and experiment reconfiguration as needed
- removing the experiments from the reactor and storing in the ATR canal during cooling
- shipping the irradiated experiment assemblies to the Hot Fuels Examination Facility (HFEF) or other appropriate facility located at the Materials and Fuels Complex (MFC).

Experiment assembly and irradiation would be a coordinated effort among INL personnel located at the Research and Education Campus (REC), MFC, and ATR Complex. Idaho National Laboratory would perform all neutronic, structural, and thermal/hydraulic analyses, and would prepare the ESAP required for ATR experiment insertion.

This sample set was selected based on specimen availability and current capabilities for handling fissile material irradiations in the HSIS. Follow-up irradiations and sample sets would be determined as specimen materials become available and progress is made with regards to redefining the amounts of fissile materials that can be irradiated in the HSIS and may require revision of this environmental checklist

Characterization of experiment materials to support the proposed action would be conducted either at external laboratories and/or various facilities at MFC that include, but are not limited to, the Electron Microscopy Laboratory, Fuels and Applied Sciences Building, and the Analytical Laboratory.

Upon discharge of each experiment from the ATR, the experiments and assemblies would be cooled until radiation levels are reduced to levels that permit safe handling and transported to MFC. The capsule assemblies would be shipped to the HFEF or another appropriate facility at the MFC for storage until programs requesting to perform PIE are identified.

The project would use either the GE-2000 or the ATR Canal Isotope Transfer Vessel for shipping the samples to MFC.

Incidental waste associated with experiment activities would be managed per the facility in which it was created. Experiment components would not be considered waste until they are no longer needed for these experiments as designated by the Experiment Manager (EM). All waste associated with the proposed action would be radiological or cold waste as determined per facility criteria. Experimental disks would be catalogued and retained. Waste would likely be the titanium capsules, stainless steel springs, spacers, and fixtures. The capsules, springs, spacers and fixtures would likely be considered low level waste that would go to the Nevada National Security Site.

The environmental impacts of transferring low level waste from the INL to the Nevada National Security Site were analyzed in the 1996 Nevada Test Site Environmental Impact Statement (EIS) (DOE/EIS-0243) and supplemental analysis (SA) (DOE/EIS-0243-SA-01) and DOE's Waste Management Programmatic EIS (DOE/EIS-200). The fourth Record of Decision (ROD) (65 Federal Register (FR) 10061, February 25, 2000) for DOE's Waste Management Programmatic EIS established the Nevada National Security Site as one of two regional low level waste (LLW) and mixed low level waste (MLLW) disposal sites. The SA considers additional waste streams, beyond those considered in the 1996 Nevada Test Site (NTS) EIS that may be generated at or sent to the Nevada National Security Site for management.

SECTION C. Environmental Aspects or Potential Sources of Impact:

Air Emissions: Air Emissions would include minor amounts of radionuclides and toxic air pollutants. Radioactive air emissions would be consistent with historical activities and is in the scope of work at HFEF, Analytical Lab, Electron Microscopy Lab, and Fuels and Applied Sciences Building. Therefore an APAD would not be required.

Generating and Managing Waste: Project personnel would work to properly package and transport regulated, hazardous or radioactive material or waste generated at the INL according to laboratory procedures. Project activities would likely result in the generation of small amounts of industrial waste. Waste would likely be the titanium capsules and fixtures (150 cubic centimeters), stainless steel springs (10 cubic centimeters), zirconium spacers (20 cubic centimeters), and aluminum fixtures (20 cubic centimeters). The project would involve non-destructive analysis of the experiments. Experimental disks would be catalogued and retained. Project personnel would work with WGS to characterize and properly dispose of all waste based on facility requirements. The capsules, springs, spacers and fixtures would likely be considered low level waste that would go to the Nevada National Security Site.

Releasing Contaminants: All chemicals utilized by the project would be managed in accordance with laboratory procedures.

Using, Reusing, and Conserving Natural Resources: All materials would be reused and recycled where economically practicable. All applicable waste would be diverted from disposal in the landfill where conditions allow. Project personnel will use every opportunity to recycle, reuse, and recover materials and divert waste from the landfill when possible. The project will practice sustainable acquisition, as appropriate and practicable, by procuring construction materials that are energy efficient, water efficient, are bio-based in content, environmentally preferable, non-ozone depleting, have recycled content, or are non-toxic or less-toxic alternatives. New equipment will meet either the Energy Star or Significant New Alternatives Policy (SNAP) requirements as appropriate (see https://sftool.gov/green-products/0/hvacmechanical?agency=0).

SECTION D. Determine the Recommended Level of Environmental Review (or Documentation) and Reference(s): Identify the applicable categorical exclusion from 10 Code of Federal Regulation (CFR) 1021, Appendix B, give the appropriate justification, and the approval date.

For Categorical Exclusions (CXs), the proposed action must not: (1) threaten a violation of applicable statutory, regulatory, or permit requirements for environmental, safety, and health, or similar requirements of DOE or Executive Orders; (2) require siting and construction or major expansion of waste storage, disposal, recovery, or treatment or facilities; (3) disturb hazardous substances, pollutants, contaminants, or Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)-excluded petroleum

and natural gas products that pre-exist in the environment such that there would be uncontrolled or unpermitted releases; (4) have the potential to cause significant impacts on environmentally sensitive resources (see 10 CFR 1021). In addition, no extraordinary circumstances related to the proposal exist that would affect the significance of the action. In addition, the action is not “connected” to other action actions (40 CFR 1508.25(a)(1) and is not related to other actions with individually insignificant but cumulatively significant impacts (40 CFR 1608.27(b)(7)).

References: 10 CFR 1021, Appendix B to Subpart D item B3.6 "Small-scale research and development, laboratory operations, and pilot projects"

Final Environmental Impact Statement for the Nevada Test Site and Off-Site Locations in the State of Nevada (DOE/EIS-0243) and supplemental analysis (SA) (DOE/EIS-0243-SA-01).

Final Waste Management Programmatic Environmental Statement for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste (May 1997) and Record of Decision (DOE/EIS-200) and Revised Record of Decision (65 FR 10061, February 25, 2000).

Justification: The proposed R&D activities are consistent with CX B3.6 "Siting, construction, modification, operation, and decommissioning of facilities for small-scale research and development projects; conventional laboratory operations (such as preparation of chemical standards and sample analysis); small-scale pilot projects (generally less than 2 years) frequently conducted to verify a concept before deomonstration actions, provided that construction or modification would be within or contiguous to a previously disturbed area (where active utilities and currently used roads are readily accessible). Not included in this category are demonstration actions, meaning actions that are undertaken at a scale to show whether a technology would be viable on a larger scale and suitable for commercial deployment."

DOE/EIS-0200 made the Nevada National Security Site available to all DOE sites for low-level waste disposal, and DOE/EIS-0243 and ROD (65 FR 10061, February 2000) analyzed the impacts of transportation from the INL and disposal at the Nevada National Security Site.

Is the project funded by the American Recovery and Reinvestment Act of 2009 (Recovery Act) ☐ Yes ☒ No

Approved by Jack Depperschmidt, DOE-ID NEPA Compliance Officer on: 3/2/2015